



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/796,146	03/10/2004	Mizuhisa Nihei	040102	2043
23850	7590	04/02/2009	EXAMINER	
KRATZ, QUINTOS & HANSON, LLP			PHAM, THANHHA S	
1420 K Street, N.W.			ART UNIT	PAPER NUMBER
Suite 400			2894	
WASHINGTON, DC 20005			MAIL DATE	
			04/02/2009	
			DELIVERY MODE	
			PAPER	

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/796,146	Applicant(s) NIHEI ET AL.
	Examiner Thanhha Pham	Art Unit 2894

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If no period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) Responsive to communication(s) filed on 05 January 2009.

2a) This action is FINAL. 2b) This action is non-final.

3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) Claim(s) 1-17 and 21-29 is/are pending in the application.

4a) Of the above claim(s) 11-17 and 21-29 is/are withdrawn from consideration.

5) Claim(s) _____ is/are allowed.

6) Claim(s) 1 and 7-10 is/are rejected.

7) Claim(s) 2-6 is/are objected to.

8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) The specification is objected to by the Examiner.

10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) All b) Some * c) None of:

1. Certified copies of the priority documents have been received.
2. Certified copies of the priority documents have been received in Application No. _____.
3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) Notice of References Cited (PTO-892)

2) Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) Information Disclosure Statement(s) (PTO/SB/06)
 Paper No(s)/Mail Date _____

4) Interview Summary (PTO-413)
 Paper No(s)/Mail Date _____

5) Notice of Informal Patent Application

6) Other: _____

DETAILED ACTION

This Office Action is in response to Applicant Amendment dated 12/01/2008.

Claim Rejections - 35 USC § 112

1. Claims 7-10 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

► With respect to claims 7 and 10,

Limitation of "a SiC substrate having ...the first upper surface being opposite to the second upper surface" is not supported by specification and figures.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 7-10 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

► With respect to claim 7,

lines 2-3, the limitation "a first upper surface and a second upper surface, the first upper surface being opposite to the second upper surface" renders the

claim indefinite. It is not clear how "the first upper surface" can be opposite to "the second upper surface"

- ▶ With respect to claim 10,

lines 2-3, the limitation "a first upper surface and a second upper surface, the first upper surface being opposite to the second upper surface" renders the claim indefinite. It is not clear what "a first and a second upper surface" means. In addition, it is not clear how "the first upper surface" can be opposed to "the second upper surface"

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1 and 7-8, as being best understood, are rejected under 35 U.S.C.

103(a) as being unpatentable over Arik et al [US 2005/0006754].

- ▶ With respect to claim 1, Arik et al (embodiment of figs 7-8, text [0001]-[0061]) discloses a semiconductor device comprising:

 a substrate (204, text [0055]); and

 a heat conductor (214, text [0056]-[0058]) formed in a first hole (microchannel 214) in the substrate and made of bundle of nanotubes (240) inherently oriented in a depth direction of the first hole,

wherein a diameter of the heat conductor is the same as a diameter of the first hole.

Embodiment of figs 7-8 of Arik et al does not specifically mention in written that:

- a)** the substrate (204) is a SiC substrate; and
- b)** the nanotubes (240) are carbon nanotubes.

In regard to **a)**, embodiment of figs 7-8 of Arik et al, instead, teaches using the substrate being of a silicon substrate for sub-mount of a heat sink arrangement. However, Arik et al (text [0040]) also teaches that the silicon substrate and silicon carbide (SiC) substrate are equivalent substrates for sub-mount of heat sink arrangement. Therefore, at the time of invention, it would have been obvious for those skilled in the art to use the SiC substrate, as being claimed, as a known and equivalent substrate for the sub-mount of the heat sink arrangement in the semiconductor device of embodiment of figs 7-8 of Arik et al to provide appropriate function of removing heat as being needed in the semiconductor device.

In regarding to **b)**, carbon nanotubes are known material for heat conductor. Selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 325 U.S. at 335, 65 USPQ at 301. See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960) (selection of a known plastic to make a container of a type made of plastics prior to the invention was

held to be obvious). In addition, Arik et al (text [0022]-[0026]) teaches using carbon nanotubes as known materials for heat conductor due to characteristics of highly thermal conductivity. Therefore, at the time of invention, it would have been obvious for those skilled in the art to use the carbon nanotubes as being claimed in the semiconductor device of embodiment of figs 7-8 of Arik et al to efficiently provide heat conducting function of the heat conductor in the semiconductor device.

► With respect to claim 7, Arik et al (embodiment of figs 7-8, text [0001]-[0061]) discloses a semiconductor device comprising:

 a substrate (204, text [0055]) having a lower first surface and a upper second surface, the lower first surface being opposite to the upper second surface;

 a first heat conductor (first heat conductor 214, figs 7-8, text [0056]-[0058]) formed in a first hole (first microchannel 214) in the lower first surface of the substrate and made of bundle nanotubes (240);

 a second heat conductor (second heat conductor 214, figs 7-8, text [0056]-[0058]) formed in a second hole (second microchannel 214) in the lower first surface of the substrate to be spaced apart from the first hole in an interval, the second heat conductor being made of bundle nanotubes (240) inherently oriented in a depth direction of the second hole; and

 an element (200, text [0055]) on the upper second surface of the substrate, wherein a diameter of the first heat conductor is the same as a diameter of the first hole and a diameter of the second heat conductor is the same as a diameter of the second hole.

Embodiment of figs 7-8 of Arik et al does not specifically mention in written that:

- a) the substrate (204) is a SiC substrate; and
- b) the nanotubes (240) are carbon nanotubes.

In regard to a), embodiment of figs 7-8 of Arik et al, instead, teaches using the substrate being of a silicon substrate for sub-mount of a heat sink arrangement. However, Arik et al (text [0040]) also teaches that the silicon substrate and silicon carbide (SiC) substrate are equivalent substrates for sub-mount of heat sink arrangement. Therefore, at the time of invention, it would have been obvious for those skilled in the art to use the SiC substrate, as being claimed, as a known and equivalent substrate for the sub-mount of the heat sink arrangement in the semiconductor device of embodiment of figs 7-8 of Arik et al to provide appropriate function of removing heat as being needed in the semiconductor device.

In regarding to b), carbon nanotubes are known material for heat conductor. Selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 325 U.S. at 335, 65 USPQ at 301. See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960) (selection of a known plastic to make a container of a type made of plastics prior to the invention was held to be obvious). In addition, Arik et al (text [0022]-[0026]) teaches using carbon nanotubes as known materials for heat conductor due to characteristics of highly

thermal conductivity. Therefore, at the time of invention, it would have been obvious for those skilled in the art to use the carbon nanotubes as being claimed in the semiconductor device of embodiment of figs 7-8 of Arik et al to efficiently provide heat conducting function of the heat conductor in the semiconductor device.

► With respect to claim 8, the claimed distance from the upper second surface of the SiC substrate to an upper surface of the second heat conductor relative (longer) to a distance from the upper second surface of the SiC substrate to an upper surface of the first heat conductor would have been obvious to an ordinary artisan practicing the invention because, absent evidence of disclosure of criticality for the range giving unexpected results, it is not inventive to discover optimal or workable ranges by routine experimentation. *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955). Furthermore, it appears that these changes produce no functional differences and therefore would have been obvious. See *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Allowable Subject Matter

4. Claim 2-6 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
5. The following are statements of reasons for the indication of allowable subject matter:

► Recorded Prior Art fails to disclose or suggest the combination structure of the semiconductor device as recited in the base claim 1 comprising: a film formed on the SiC substrate; a second hole formed in the film, the second hole being located on the heat conductor; an electrode formed in the second hole and directly connected to the heat conductor as characteristics in claim 2.

6. The following claims 9 and 10 drafted by the examiner and considered to distinguish patentably over the art of record in this application, are presented to applicant for consideration:

Claim 9:

*A semiconductor device comprising:
a SiC substrate having a lower first surface and a upper second
surface, the lower first surface being opposite to the upper second
surface;*

*a first heat conductor formed in a first hole in the lower first surface
of the SiC substrate and made of bundle of carbon nanotubes;*

*a second heat conductor formed in a second hole in the lower first
surface of the SiC substrate to be spaced apart from the first hole in an
interval, the second heat conductor being made of bundle of carbon
nanotubes oriented in a depth direction of the second hole; and*

*an element on the upper second surface of the SiC substrate,
wherein the element is an HEMT, and at least a part of the second heat*

conductor located between a gate electrode and a drain electrode of the HEMT when view from above the SiC substrate.

wherein a diameter of the first heat conductor is the same as a diameter of the first hole and a diameter of the second heat conductor is the same as a diameter of the second hole.

Claim 10:

*A semiconductor device comprising:
a SiC substrate having a lower first surface and a upper second surface, the lower first surface being opposite to the upper second surface;*

a first heat conductor formed in a first hole in the lower first surface of the SiC substrate and made of bundle of carbon nanotubes oriented in a depth direction of the first hole;

a second heat conductor under and directly contact the lower first surface of the SiC substrate and the first heat conductor, the second heat conductor being formed to cover the lower first surface of the SiC substrate entirely and made of bundle of carbon nanotubes oriented in the same direction to the oriented bundle of carbon nanotubes of the first heat conductor; and

*an element on the upper second surface of the SiC substrate,
wherein a diameter of the first heat conductor is the same as a diameter of the hole.*

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (571) 272-1696. The examiner can normally be reached on Monday and Thursday 9:00AM - 9:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kimberly Nguyen can be reached on (571) 272-2402. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Thanhha Pham/
Primary Examiner, Art Unit 2813

Application/Control Number: 10/796,146
Art Unit: 2894

Page 11